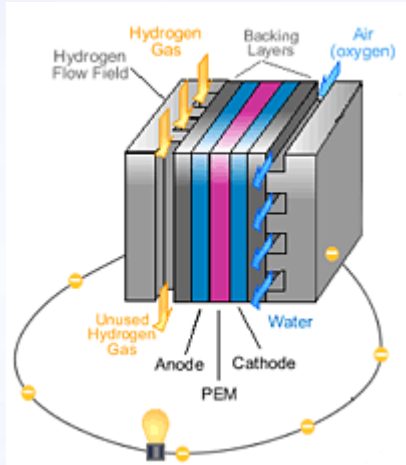
2007 Annual DOE Hydrogen Program Review

Systems Analysis

Session



Introduction

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Outline

- Introduction
- Analysis Strategy and Domains
- Analysis Portfolio
- Model/Analysis Application Matrix
- Systems Approach
- “Producing results”

Introduction

What Questions Should Analysis and Models Answer?

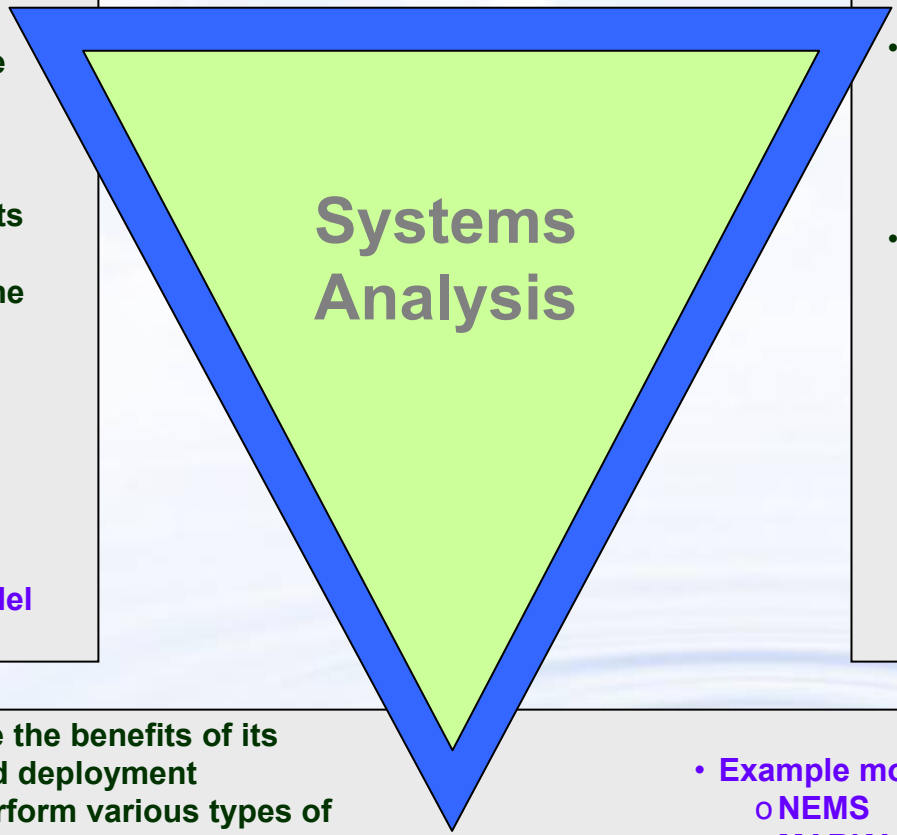
Analysis Progression

Initial Questions and Problems to Address with Analysis	Integrating Questions and Problems to Address with Analysis	Long Term Questions and Problems to Address with Analysis
• What are the key technology drivers?	• Which portfolio of technologies will best fit and where (cost, resource availability, infrastructure availability, etc.)	• What policies will be needed to enable hydrogen production, delivery and vehicles?
• What is the hydrogen cost of the technologies?	• How will the infrastructure evolve?	• Which policies will be more effective for vehicle introduction and for hydrogen/infrastructure introduction?
• Where do we focus our research i.e. which technology/ies and what area of the technologies?	• What are the infrastructure requirements in cost?	• What is the impact of switching from a petroleum based transportation fuel to a hydrogen based fuel?
• What are the resource requirements/ limitations?	• What will be the impacts on petroleum use and greenhouse gas emissions as the infrastructure and technologies are introduced?	
• What are the hydrogen quality requirements and cost implications?	• What and where are the infrastructure constraints to meet the technology requirements?	
• What technologies will be needed to meet the hydrogen quality specifications?	• Does the vehicle need to be built first or is a fueling infrastructure required first (how to manage the “chicken and egg” issue)?	

Analysis Strategy and Domains

Technical Analysis

- Resource, technical feasibility, environmental, delivery, and infrastructure development analysis
- Assists in defining the appropriate slate of projects for the hydrogen research portfolio, and increasing the effectiveness of research projects
  - Example models:
    - PSAT
    - GREET
    - HyDS
    - Macro-System Model
    - HYPRO



Cost Analysis

- Analysis to assess the economic feasibility of various infrastructure and vehicle processes
- Assists in choosing research paths which offer the best possibilities of competitive costs for hydrogen production, delivery, vehicle configurations, etc.
  - Example models:
    - H2A
    - TIAX Logistics Model

Market/Benefits Analysis

- Analysis to estimate the benefits of its portfolio of R&D and deployment programs and to perform various types of policy analyses
- Examination of the interactions of hydrogen production and consumption with the rest of the energy system
  - Example models:
    - NEMS
    - MARKAL
    - HyTrans
    - VISION

Analysis Portfolio

- Technology Analysis
  - Pathway & Components cost analysis
  - Hydrogen quality impact analysis
  - Well-to-Wheels (WTW) Energy & Greenhouse Gas (GHG) emissions analysis
  - Vehicle technology analysis
- Implementation & Impact analysis
  - Infrastructure & resource analysis
  - Consumer choice analysis
  - Vehicle penetration analysis
- Policy Analysis
  - National economic impact analysis
  - Policy options analysis
- System Dynamics analysis
- Environmental analysis

Model/Analysis Application Matrix

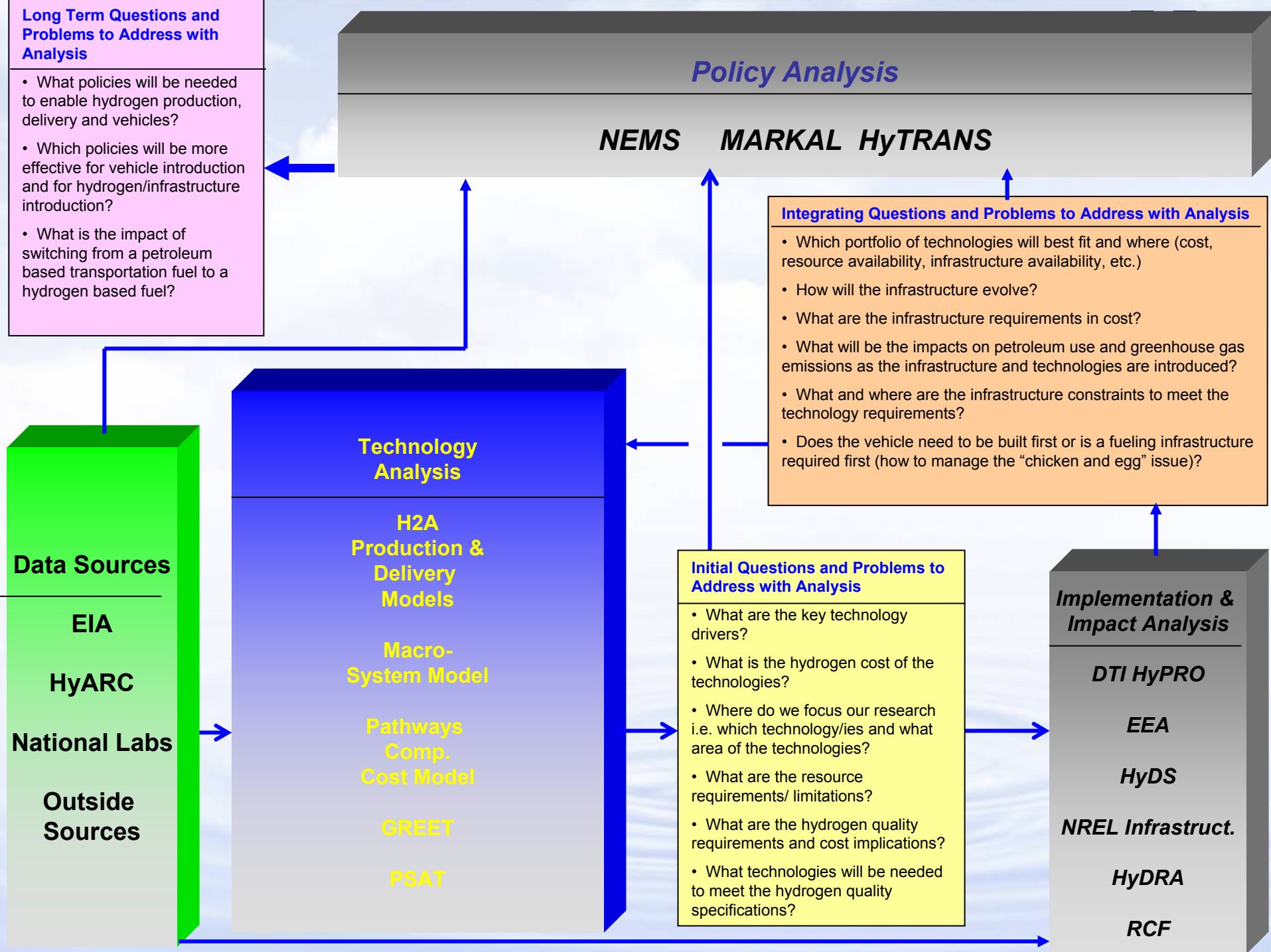
Analysis Category	Technology Analysis				Implementation & Impact Analysis			Policy Analysis		
Analysis Type / Models	Pathway & Components Cost	H2 Quality Impact	WTW Energy & GHG Emissions	Vehicle Technology	Infrastructure & Resource Anal.	Consumer Choice	Vehicle Penetration	National Econ. Impacts	Policy Options	System Dynamics
H_2A Production Cost Model[1]	■									
H_2A Delivery Cost Model[1]	■									
DTI HyPRO[1]					■					
EEA[1]					■					
HyDS[1]					■					
NREL Infrastructure[1]					■					
HyDRA[1]					■					
PSAT				■						
HyTrans[1]						■	■		■	
GREET[1]			■							
Macro-System Model (MSM) [1]	■	■								
RCF Agent Based Model[1]					■					
NEMS								■	■	
MARKAL								■	■	
HyDive[1]										■
Hydrogen Logistics Model (TIAX)					■					

Notes:

1. The models/projects funded by Systems Analysis are referenced with a "1".
2. A hydrogen module is being added to the NEMS model in 2006.
3. Risk analysis is being incorporated in the models. The GREET Model has risk analysis capabilities.
4. The primary analysis focus of the models are illustrated in the matrix. However, the models are multi-functional and can be applied for other analyses in the matrix.

Legend

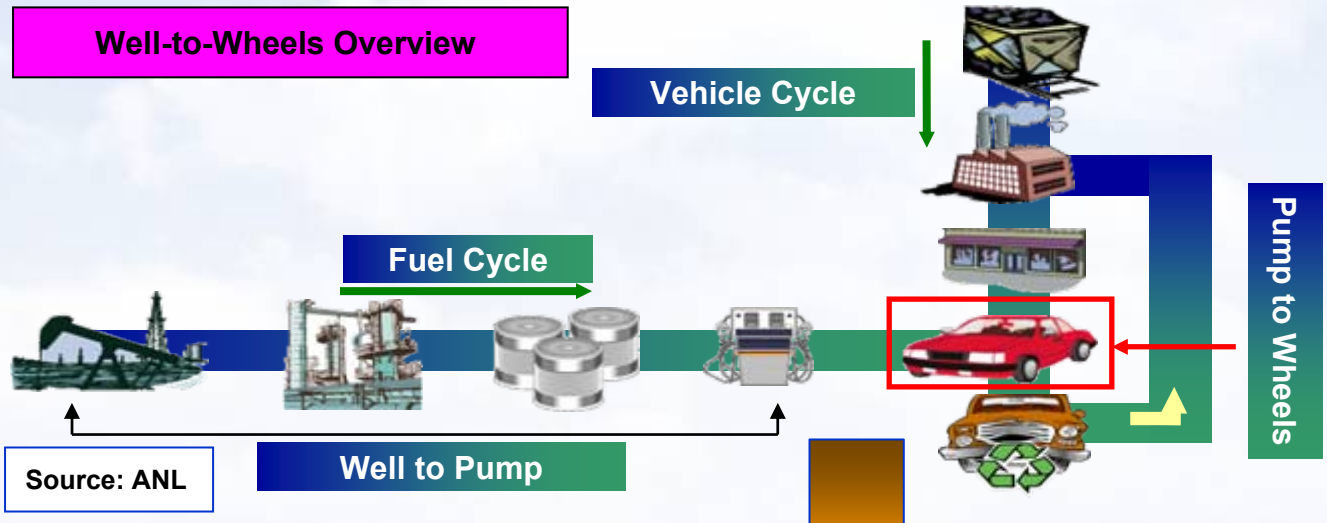
- ■ Completed Models
- ■ Models Underdevelopment
- ■ Planned Models


Long Term Questions and Problems to Address with Analysis
• What policies will be needed to enable hydrogen production, delivery and vehicles?
• Which policies will be more effective for vehicle introduction and for hydrogen/infrastructure introduction?
• What is the impact of switching from a petroleum based transportation fuel to a hydrogen based fuel?
Policy Analysis
NEMS MARKAL HyTRANS
Integrating Questions and Problems to Address with Analysis
• Which portfolio of technologies will best fit and where (cost, resource availability, infrastructure availability, etc.)
• How will the infrastructure evolve?
• What are the infrastructure requirements in cost?
• What will be the impacts on petroleum use and greenhouse gas emissions as the infrastructure and technologies are introduced?
• What and where are the infrastructure constraints to meet the technology requirements?
• Does the vehicle need to be built first or is a fueling infrastructure required first (how to manage the "chicken and egg" issue)?
Data Sources
EIA
HyARC
National Labs
Outside Sources
Technology Analysis
H2A Production & Delivery Models
Macro-System Model
Pathways Comp. Cost Model
GREET
PSAT
Initial Questions and Problems to Address with Analysis
• What are the key technology drivers?
• What is the hydrogen cost of the technologies?
• Where do we focus our research i.e. which technology/ies and what area of the technologies?
• What are the resource requirements/ limitations?
• What are the hydrogen quality requirements and cost implications?
• What technologies will be needed to meet the hydrogen quality specifications?
Implementation & Impact Analysis
DTI HyPRO
EEA
HyDS
NREL Infrastruct.
HyDRA
RCF

DOE Well-to-Wheels Analysis Methodology

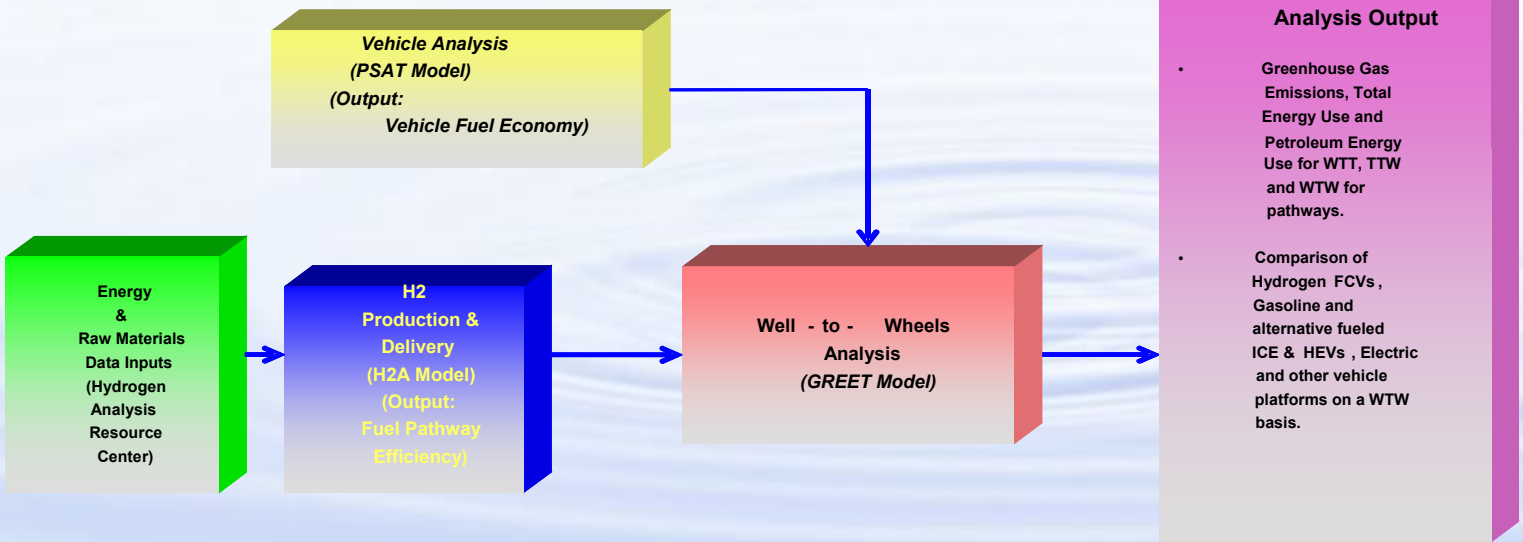
A "Systems" Approach

Well-to-Wheels Overview



Source: ANL

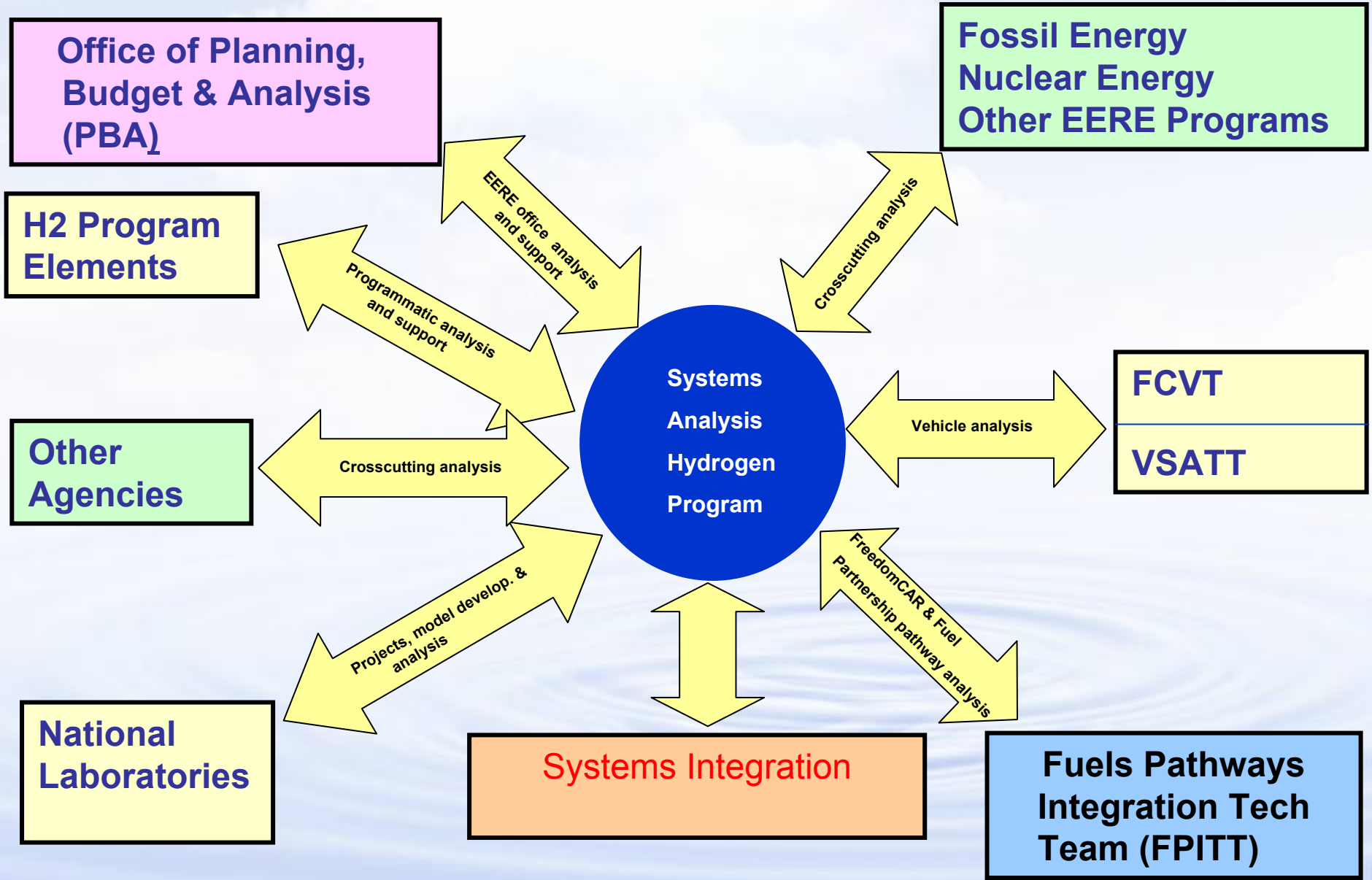
Well-to-Wheels Modeling Process



"Producing Results"

Analysis Topics	Model Utilized
Hydrogen Cost Goal	PSAT (Powertrain Systems Analysis Toolkit)
Distributed Natural Gas Reformer Independent Study	H2A Production Model (DOE)
Scenario Analysis of the Transition	H2A Production Model (DOE) H2A Delivery Model (DOE) HyPRO Model (Directed Technologies, Inc.) HyTrans (Oak Ridge National Lab)
Pathway Well to Wheels Evaluations	GREET Model (Argonne National Lab)
Electrolyzer Production Technology Evaluation	H2A Production Model (DOE)
Techno-economic evaluation of Production Technologies	H2A Production Model (DOE) GREET Model (DOE)
Resource Analysis: CO2 Water Use Analysis Natural Gas Infrastructure Limitations	 EEA Model H2A Production Models EEA Model
Pathway cost and WTW analysis of hydrogen leakage Pathway WTW sensitivity for production and vehicle impacts	Macro-System Model

Systems Analysis Partners



Thank You